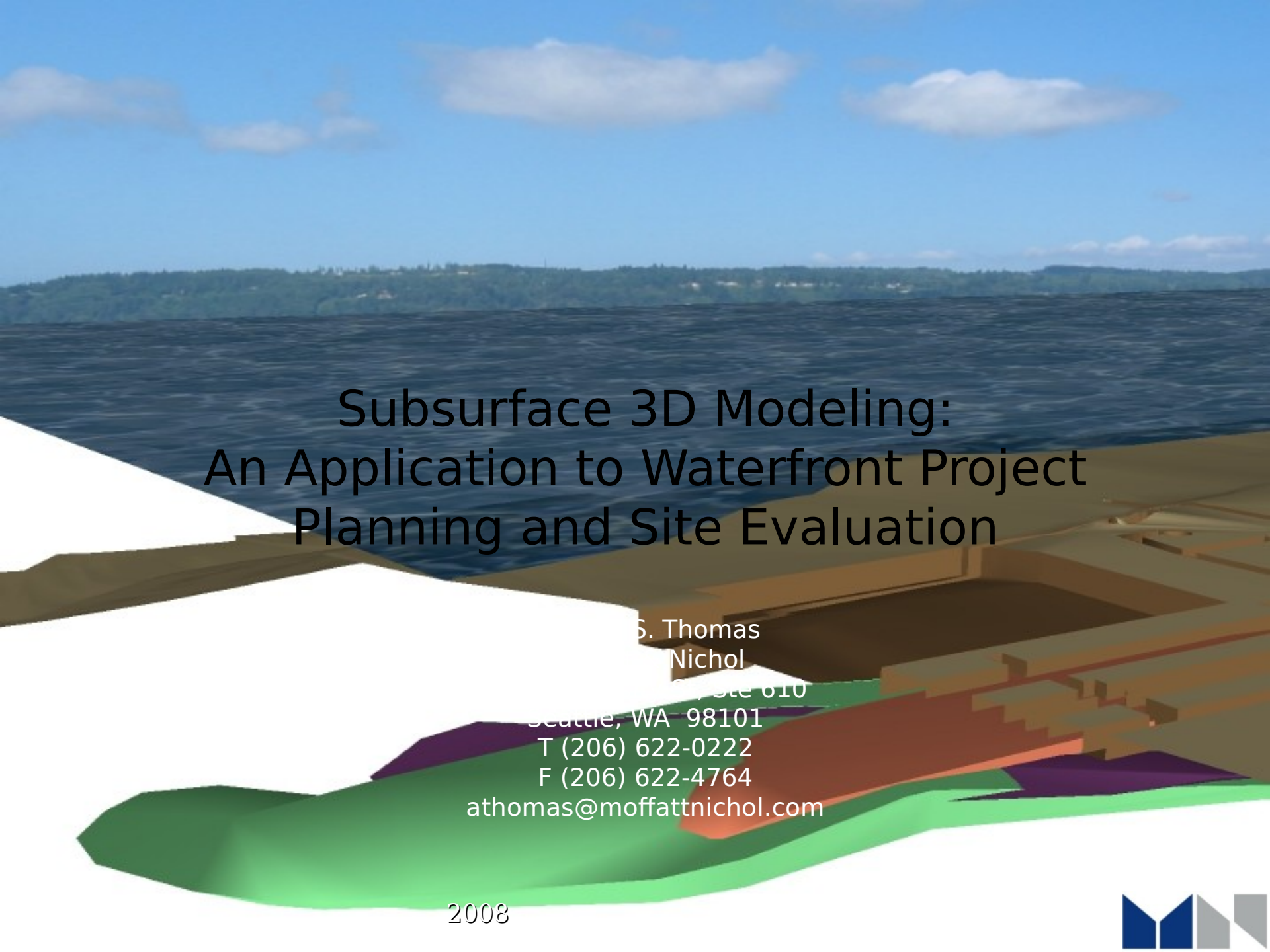

Subsurface 3D Modeling: An Application to Waterfront Project Planning and Site Evaluation

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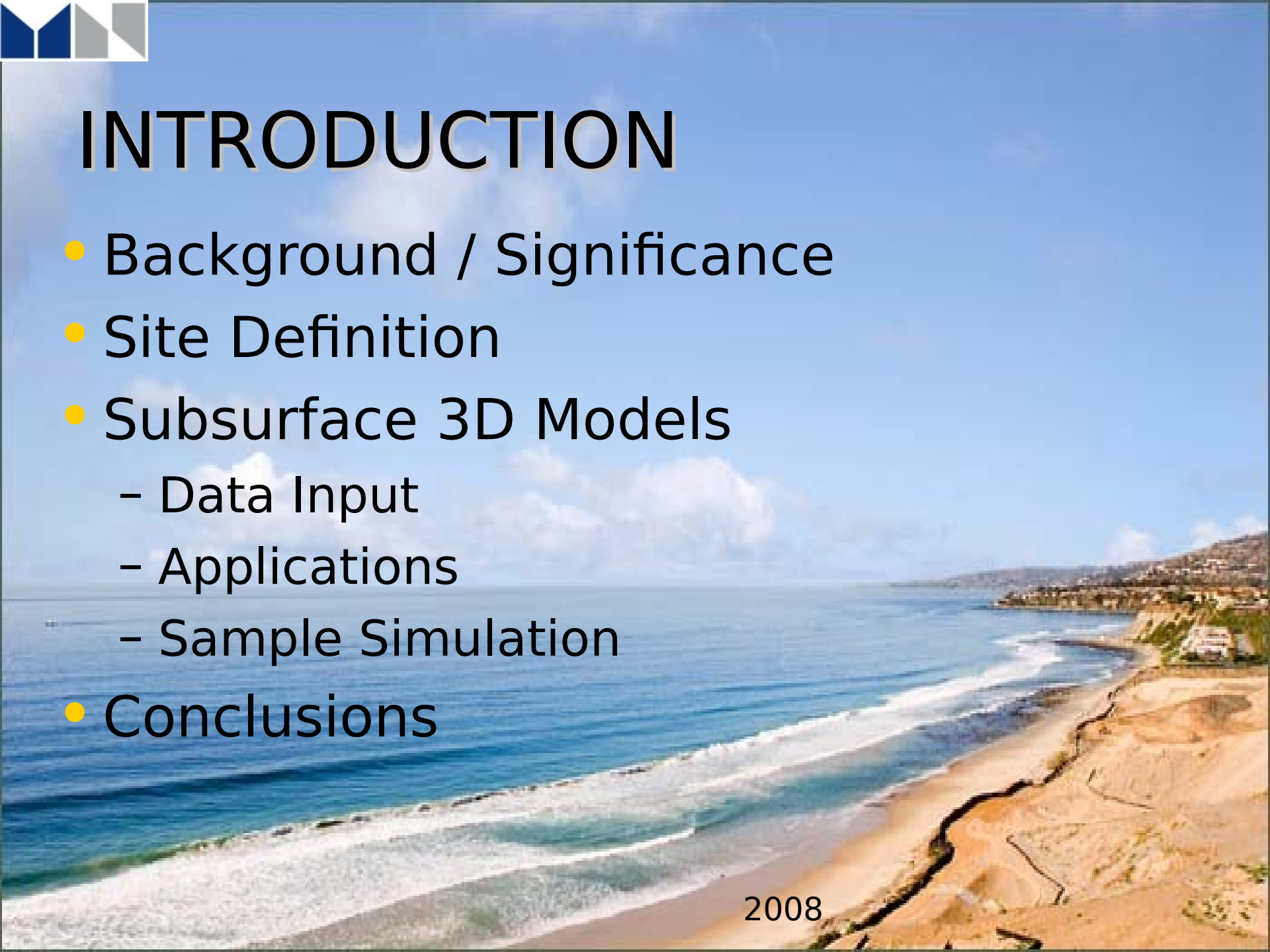
INTRODUCTION

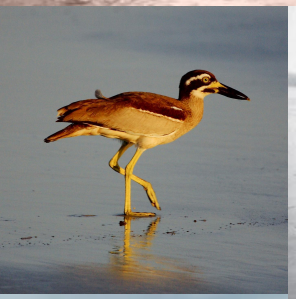
- Background / Significance
- Site Definition
- Subsurface 3D Models
  - Data Input
  - Applications
  - Sample Simulation
- Conclusions



Background / Significance

- Why is it important to know what lies beneath a project site?
- How do subsurface conditions relate to the waterborne transportation industry?

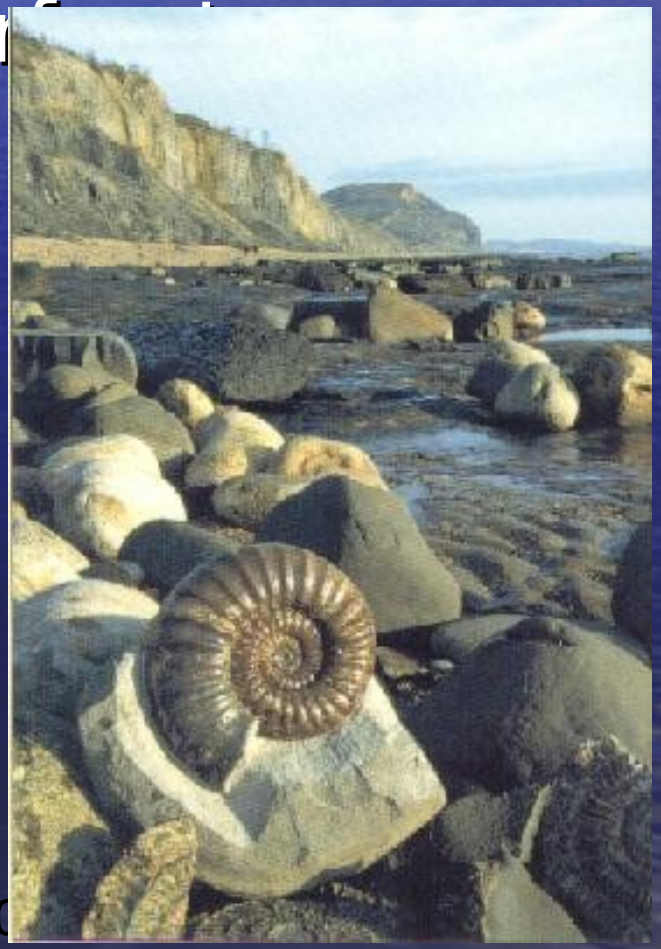
Background / Significance



Bodies of water have always provided a means of life

Background / Significance

- Archaeological discoveries are common near the water



Background / Significance

- Archaeological discoveries can be exciting and devastating at the same time
- Unanticipated finds can be costly to a

Construction on schedule

Archaeological Investigation

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Background / Significance

- The waterborne transportation industry is vital in maintaining and improving the world's economy
- Industry's need for waterfront access points
- Waterfront sites have limited availability:

  increasing development = decreasing availability

Site Definition

- Decreasing availability along the waterfront leads to increased consideration of a site's characteristics

- Site history – early considerations
  - How will the development affect the site?
  - How will the site affect the development?
  - What lies beneath the site, and how can its arrangement be conveyed to those that need to know?

Site Definition

- Important to define and evaluate a site's Area of Potential Effects (APE)

36 CFR Part 800 – Protection of Historic Properties

Section 800.16 (Definitions):

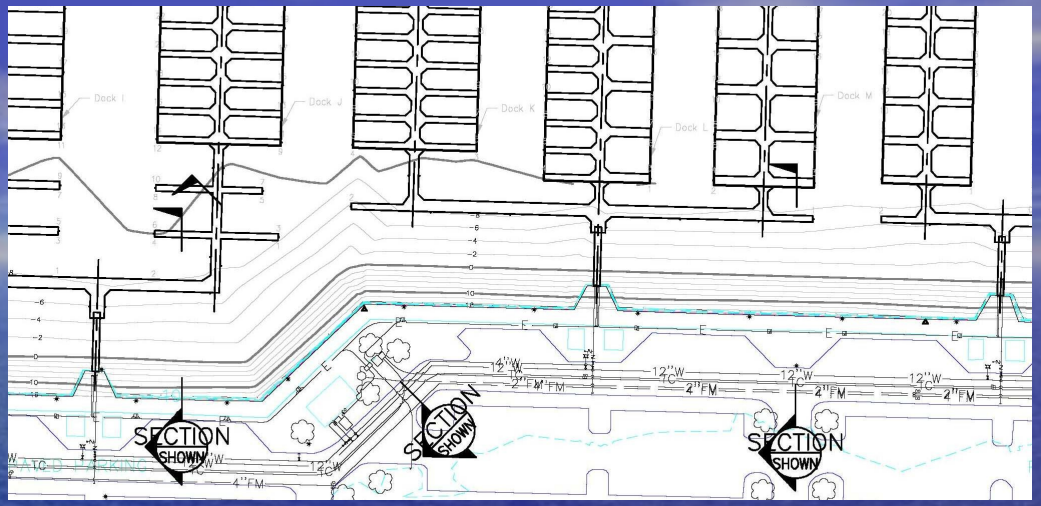
Area of Potential Effects: *The geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of the undertaking and may be different for different kinds of effects caused by the undertaking.*

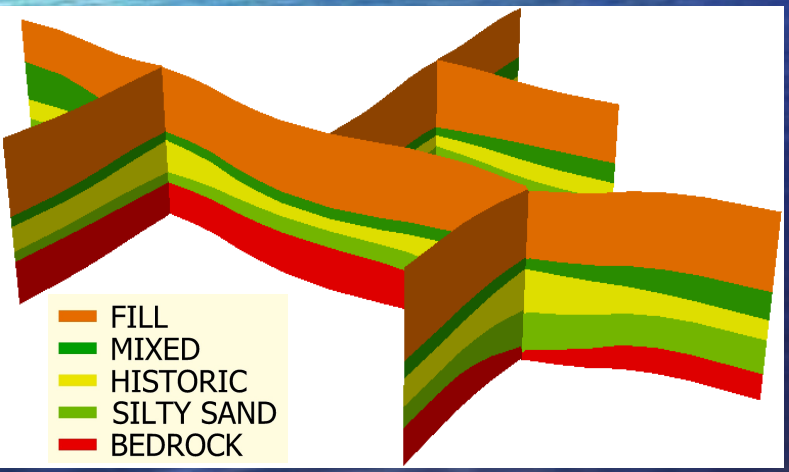
Site Definition

- Sources of data for physical representation of APE:
  - -EXPERT INPUT
  - -Aerial Photography
  - -Historic Design Drawings
  - -Geologic Profiles
  - -Site Photographs
  - -Predictive & GIS Maps
  - -Survey Data
  - -Environmental Studies
  - -Concept Drawings
  - -Project Reports
- Data is collectively reviewed by:
  - -Owners
  - -Engineers & Planners
  - -Environmental Scientists
  - -Archaeologists
  - -Geologists
  - -Geomorphologists
  - -Cultural Resources Experts
  - -Regulatory Agencies
  - -Other Stakeholders
- Widespread data collection and review can be expensive and time-consuming; overall, data should be used effectively to justify the effort

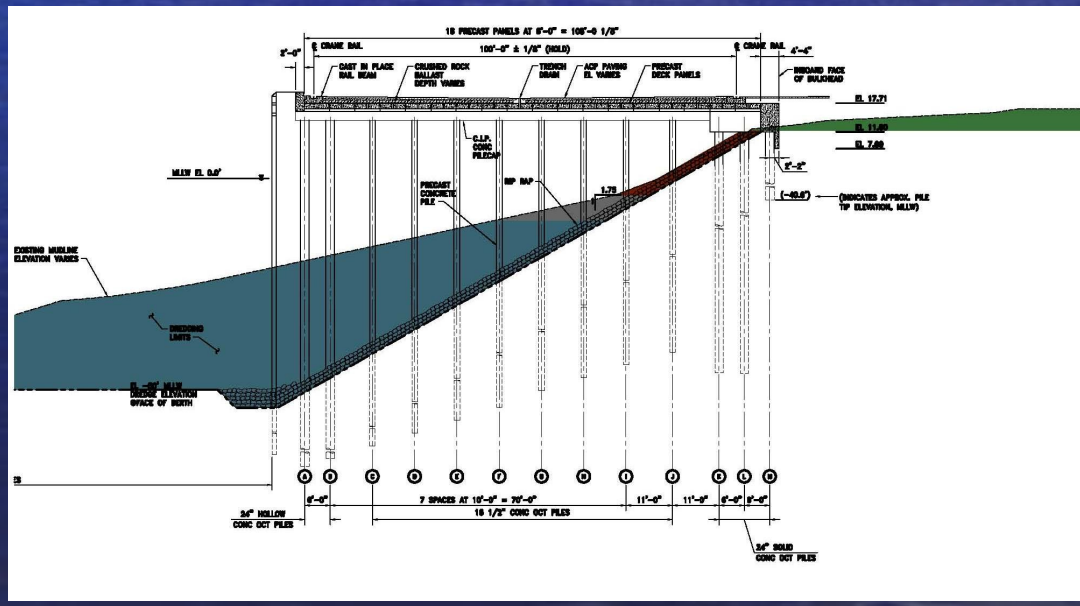
Site Definition

- Data display examples





Subsurface Layers - Fence Diagram



Project Design - Plan & Section Drawings

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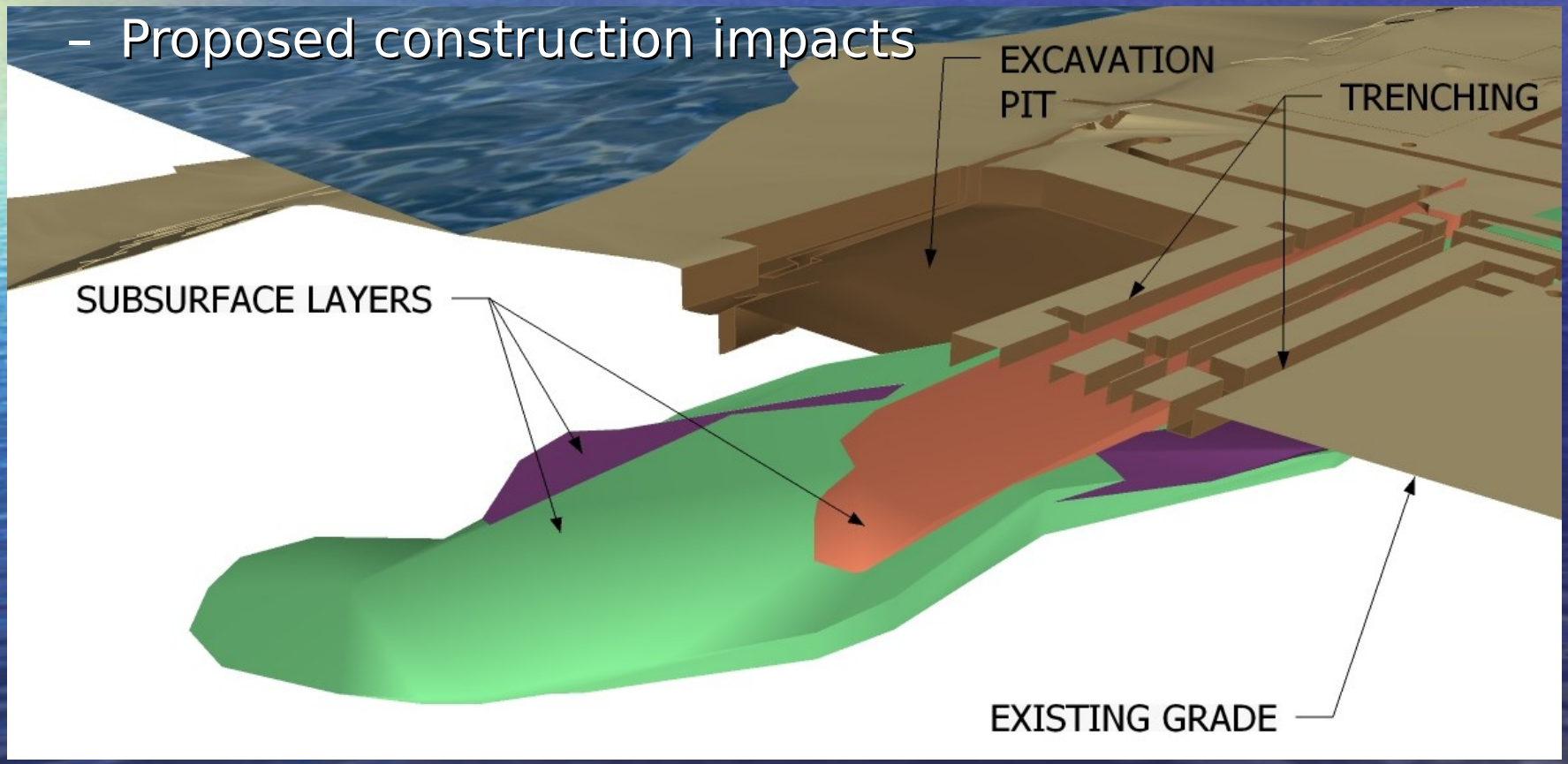
SUBSURFACE 3D MODELS

- A subsurface 3D model provides a single display of:
  - An existing site and its subsurface layers
  - Historic excavations / impacts
  - Proposed construction impacts



SUBSURFACE 3D MODELS

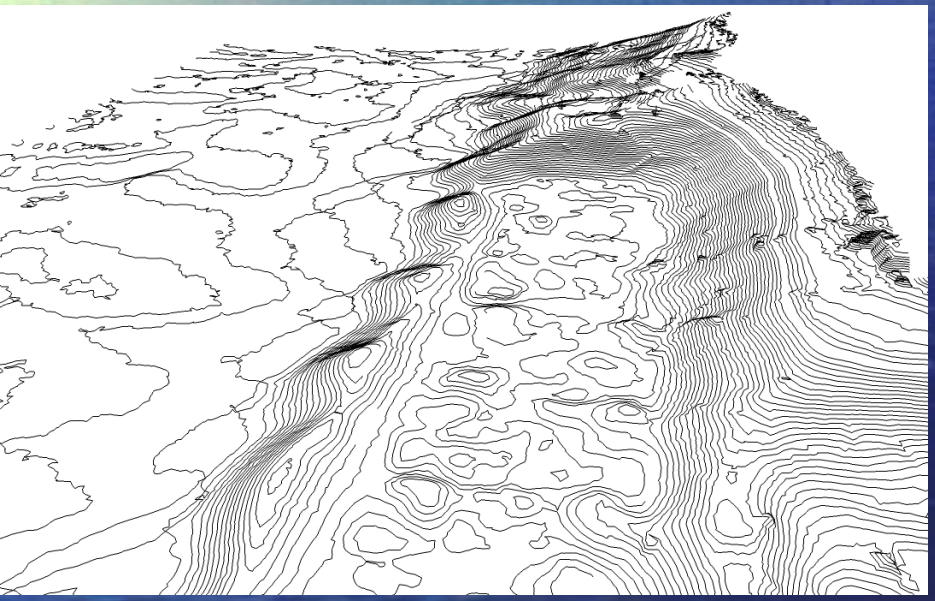
- Key features:
  - A subsurface 3D model exhibits thousands of precise, physical survey points
  - 3D models are interactive
    - Users have the ability to rapidly zoom into or out of any point in the display
    - A user can navigate around a 3D model by orbiting the viewpoint so anything in the model can be seen from anywhere
  - Sections cuts and measurements can be taken during a viewing session
  - Uninhibited display allows interpolations between data points to be seen clearly at all times

Data Input

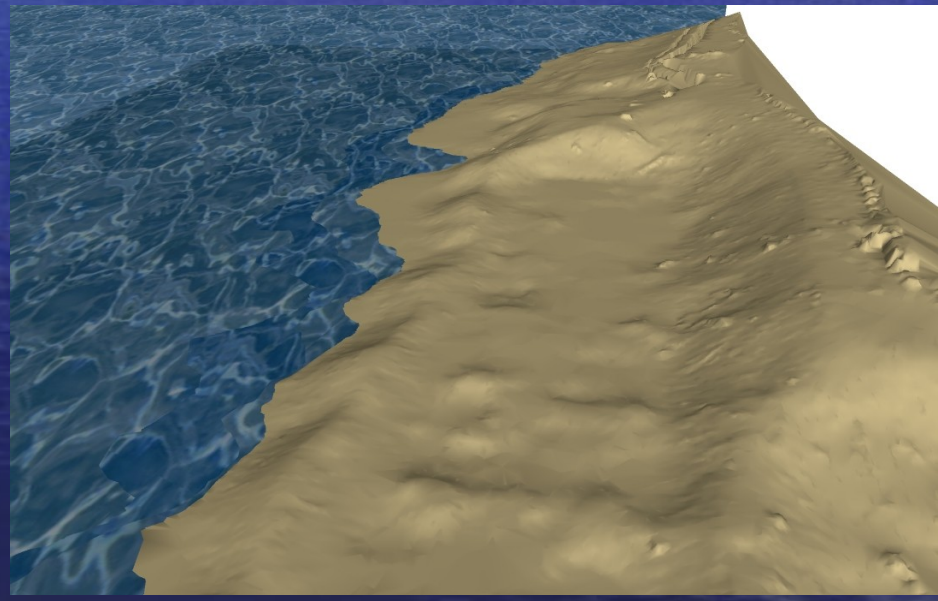
- The accuracy of the model depends on the accuracy of the data collected
  - Historic Excavations
    - As-built drawings
  - Proposed Excavations
    - Concept Drawings (Alternative Project Layouts)
    - Plan & Section Drawings
  - Existing Subterranean Conditions
    - Project Report Graphs & Figures
    - Geotechnical Boring Logs
    - Stratigraphic Sections
    - Archaeological Trench Profiles
    - Topography - Survey Data / Contour Lines

Data Input – Terrain Development

Survey → Contour Lines → Surface Display



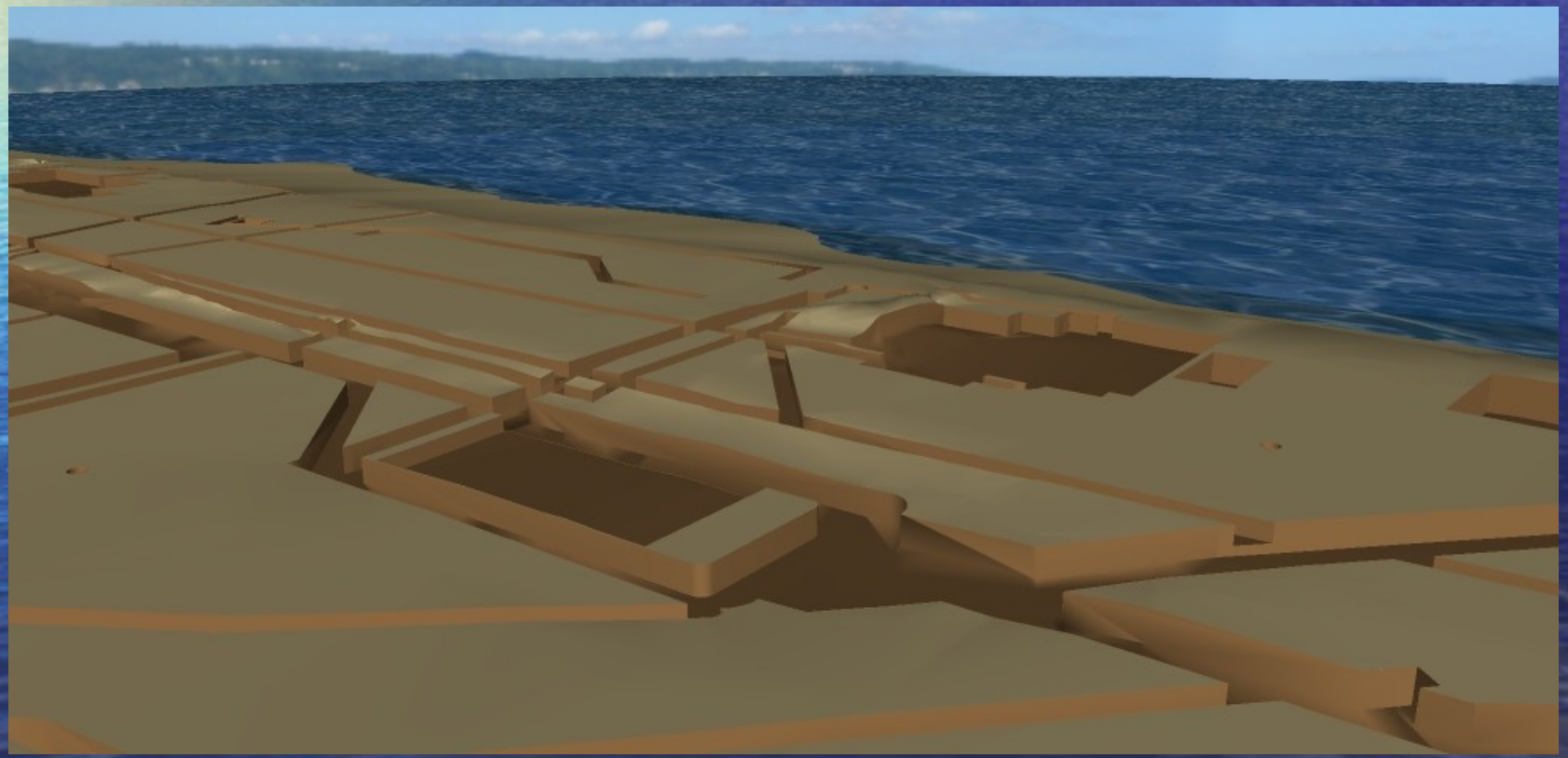
3D Contour Lines



Resultant Surface

Data Input –Excavations

- Available design drawings can be used to locate proposed and/or historic excavations in plan view
- If section drawings and grading plans are not available, excavation depths can be estimated
- Once defined, excavations are cut into the 3D terrain



Data Input – Subsurface Conditions

- Borehole Data: basis for defining subsurface formations
  - Soil sample locations should be chosen appropriately
  - Layers can be initially identified by reviewing borehole/well logs

Data Input – Subsurface Conditions

- Archaeological Trenches
  - If archaeological remnants are suspected, a series of archaeological trenches are excavated and explored
  - Trench profiles can be reviewed to provide further subsurface definition (IE more points to combine with borehole data)

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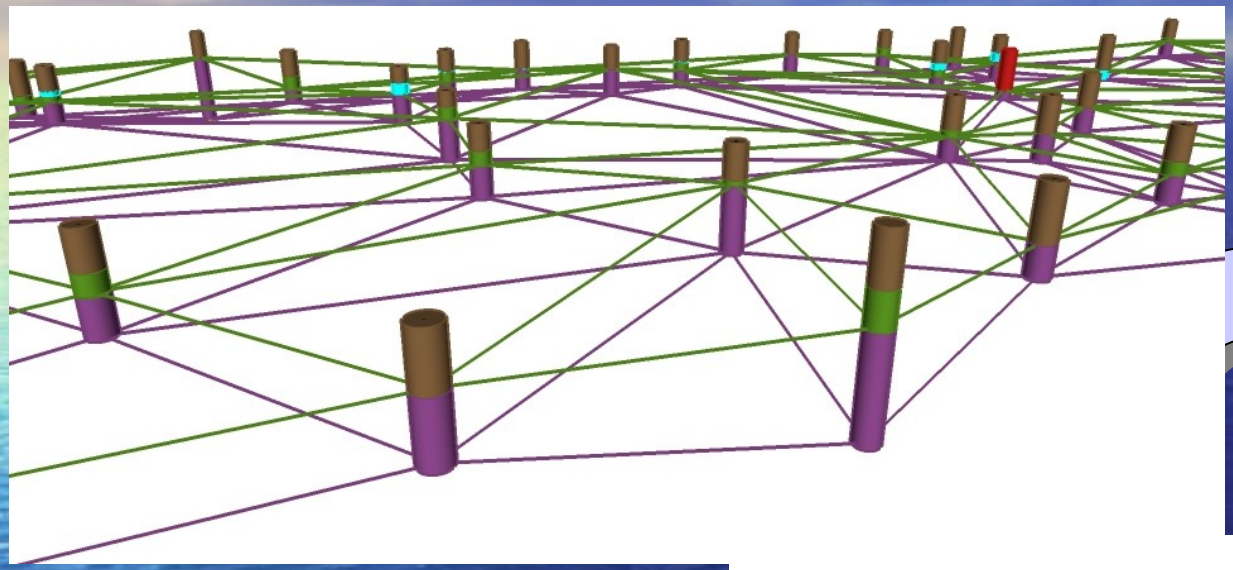
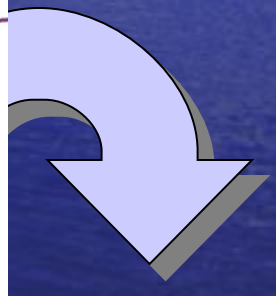
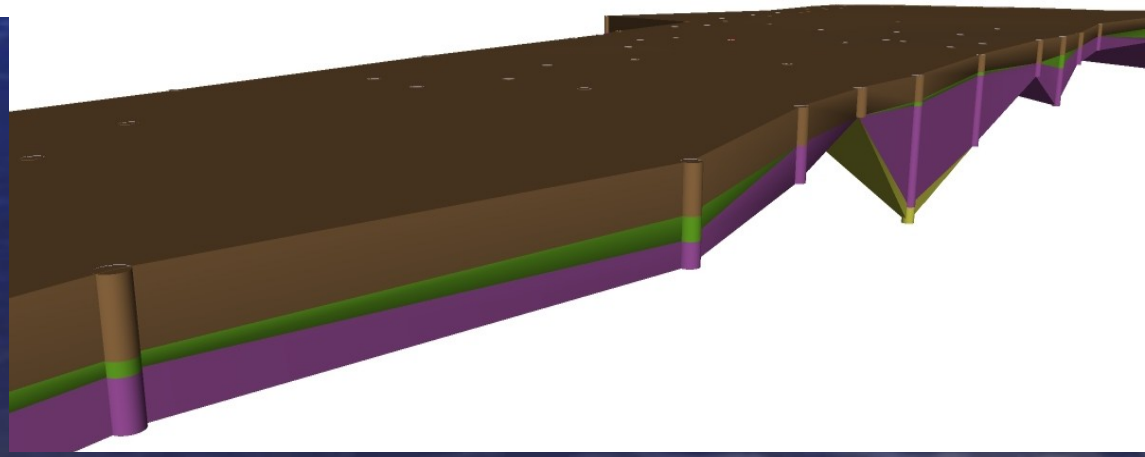
Data Input – Subsurface Conditions

- With data points, a triangulated irregular network (TIN) is formed for each layer

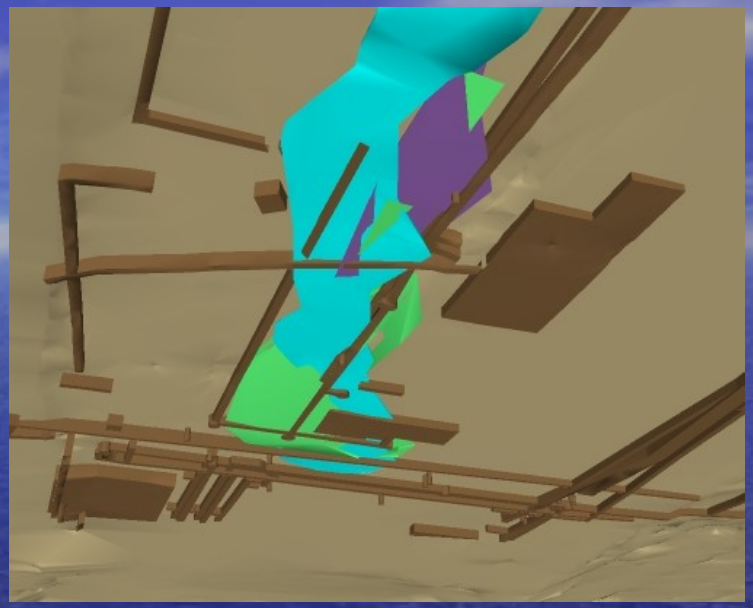




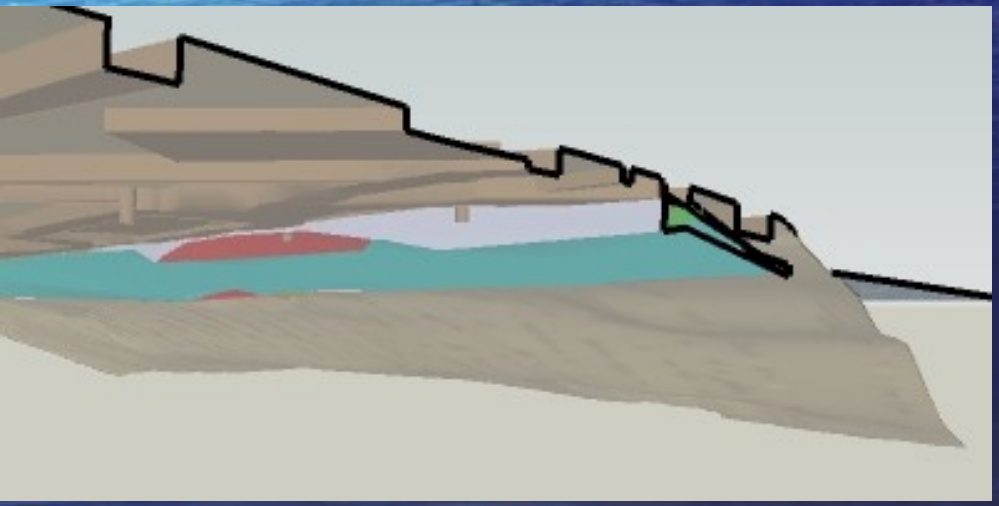


Applications – Sample Views

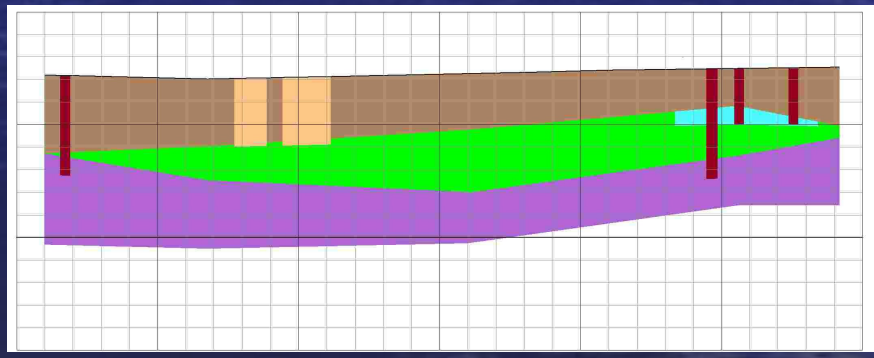
Plan View



Subterranean View



Section Cut



Cross Section

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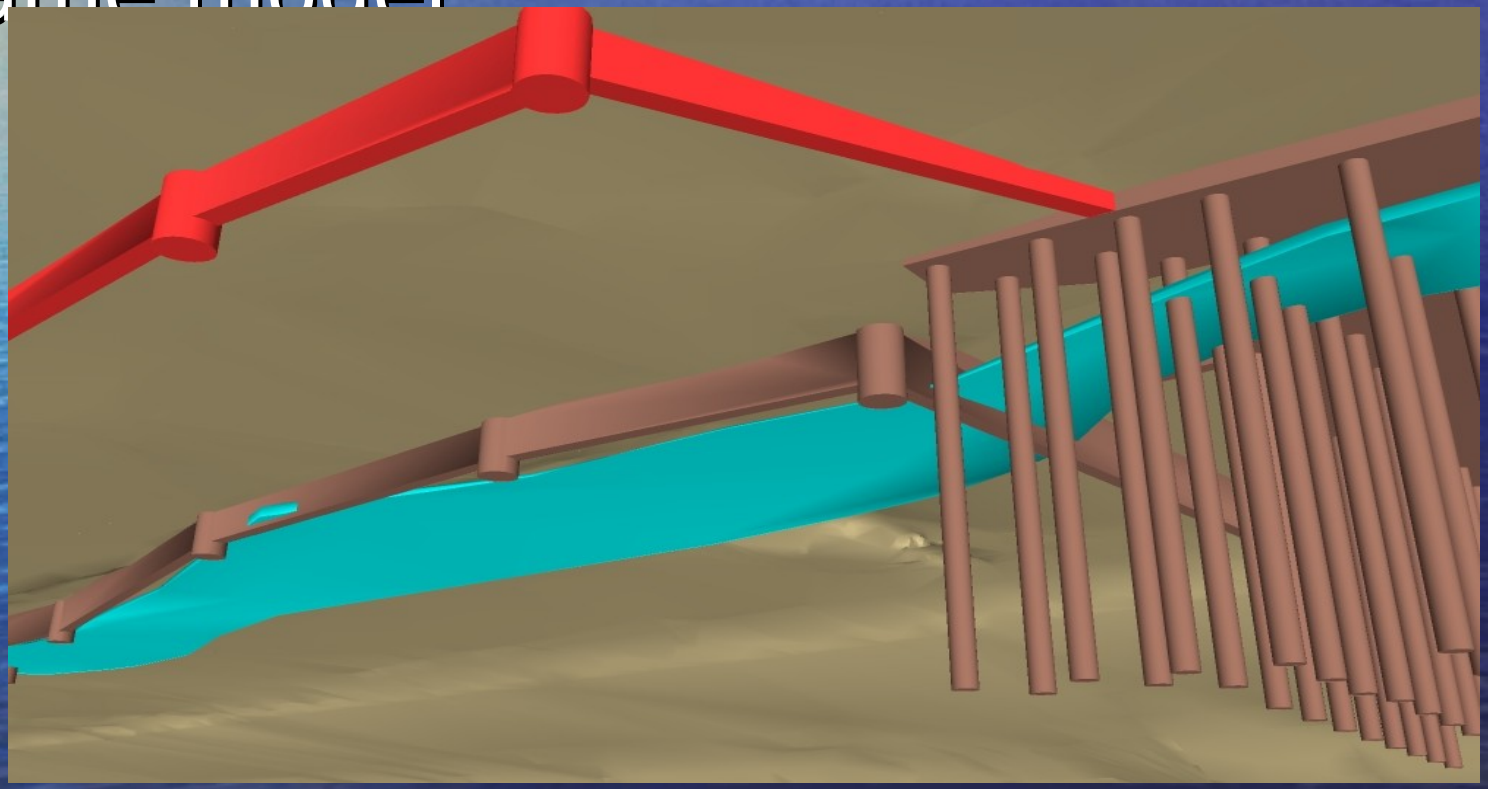
Applications – Comparison of Project Alternatives

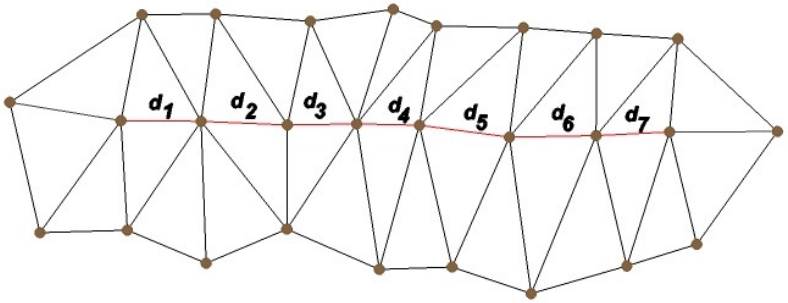
- Excavations from multiple alternatives can be compared in the same model

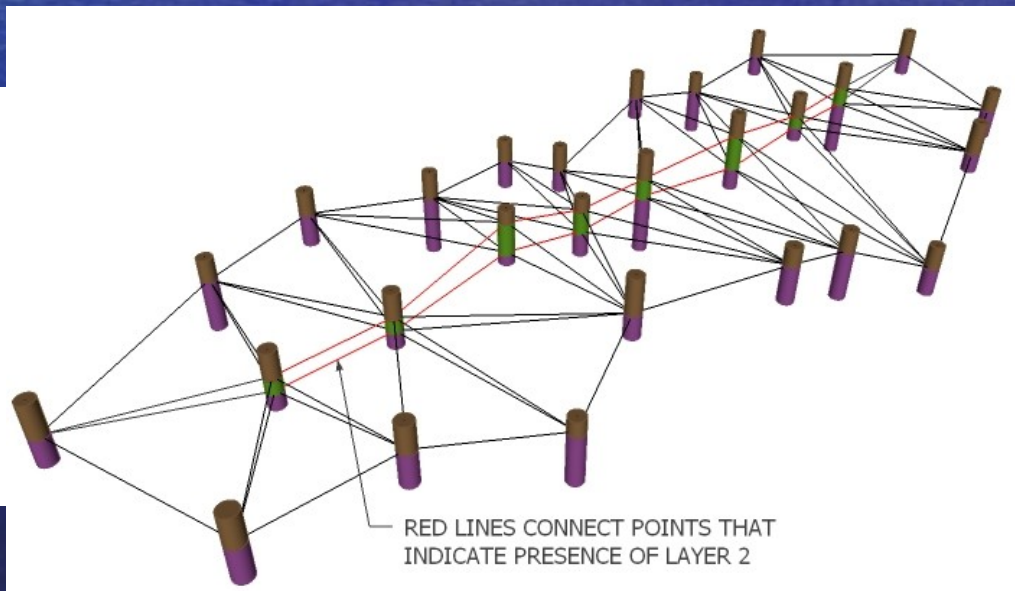


Subterranean View – comparison of alternative utility layouts

Applications – Layer Definition Process

- Some subsurface layers are more significant than others and require special consideration
- Example:

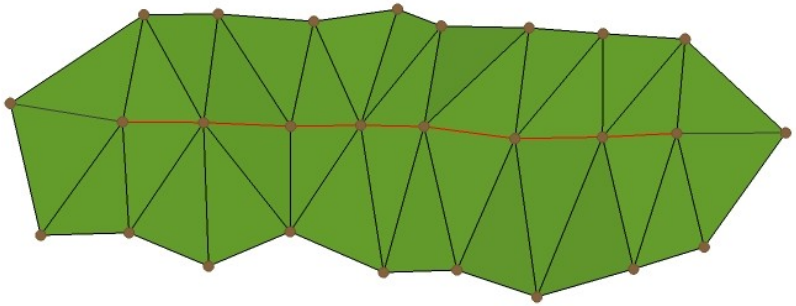


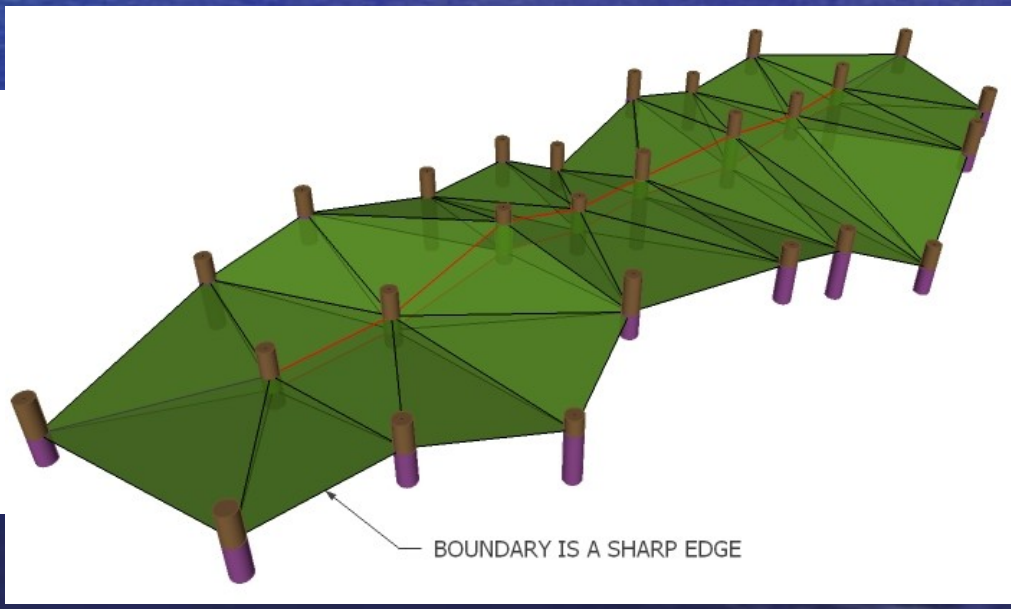


Borings and TIN lines for a subsurface layer

Applications – Layer Definition Process

- Example continued

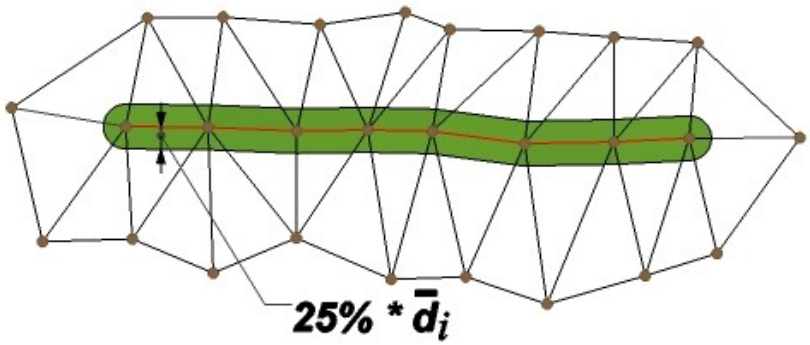


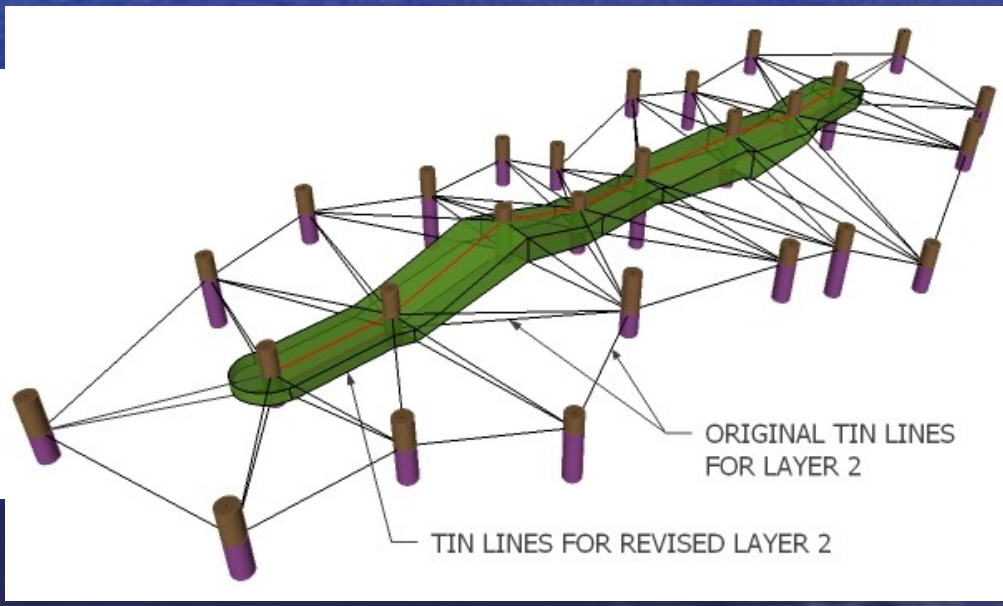


Borings and TIN lines for a subsurface layer

Applications – Layer Definition Process

- Example continued

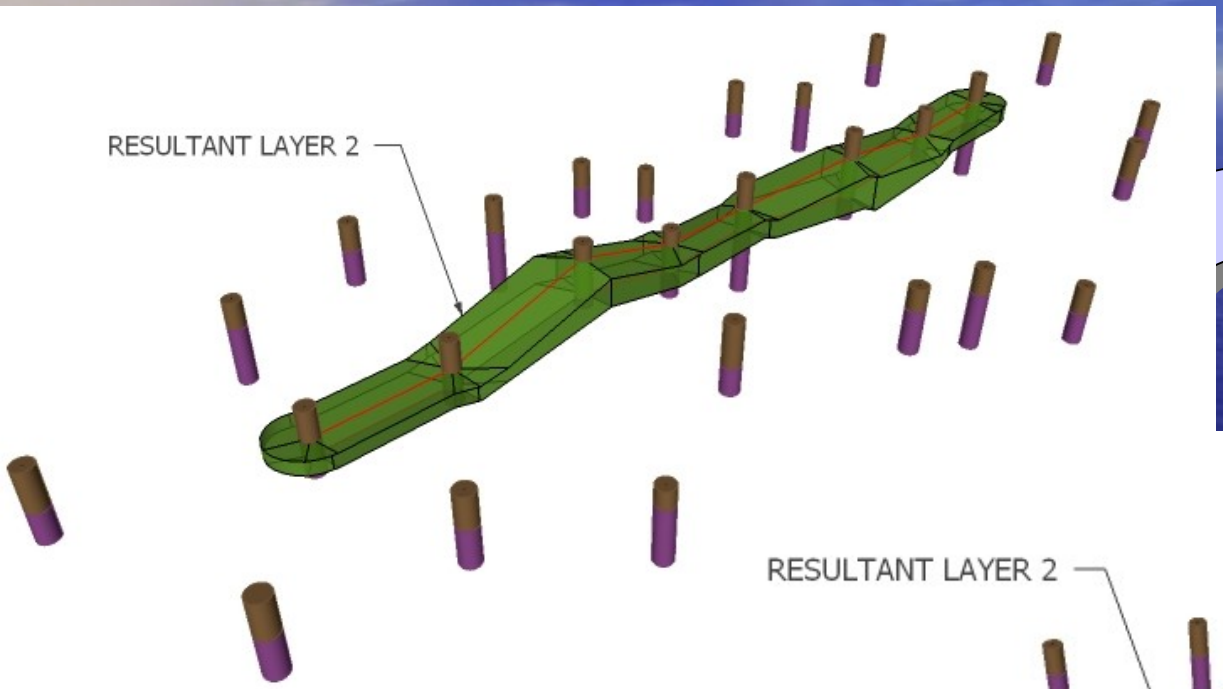


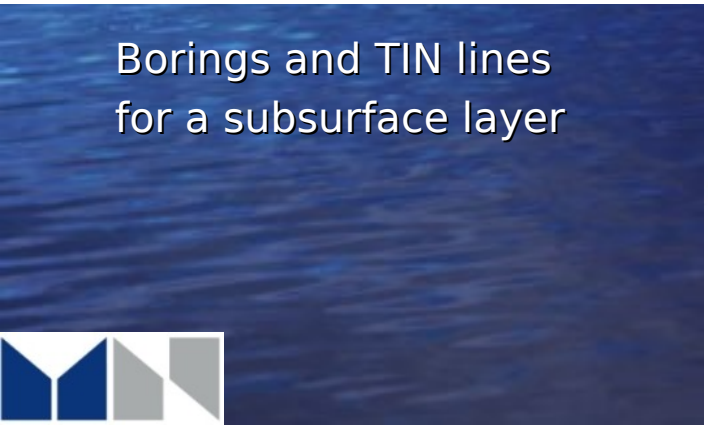


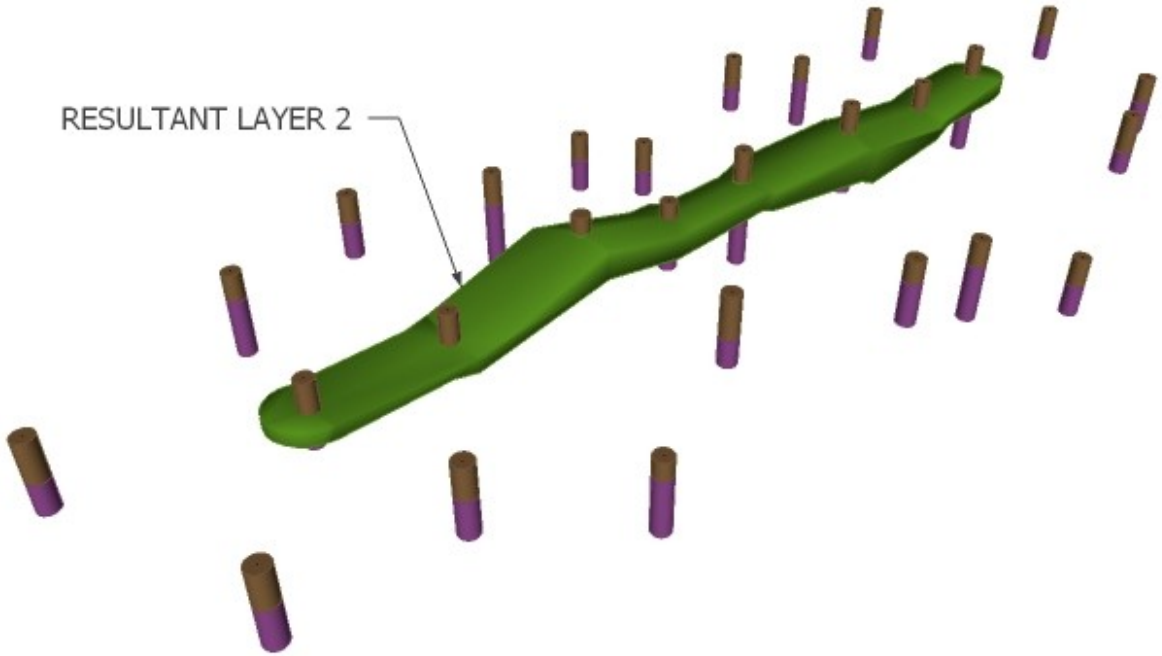
Borings and TIN lines for a subsurface layer

Applications – Layer Definition Process

- Example – Final Definition of Layer







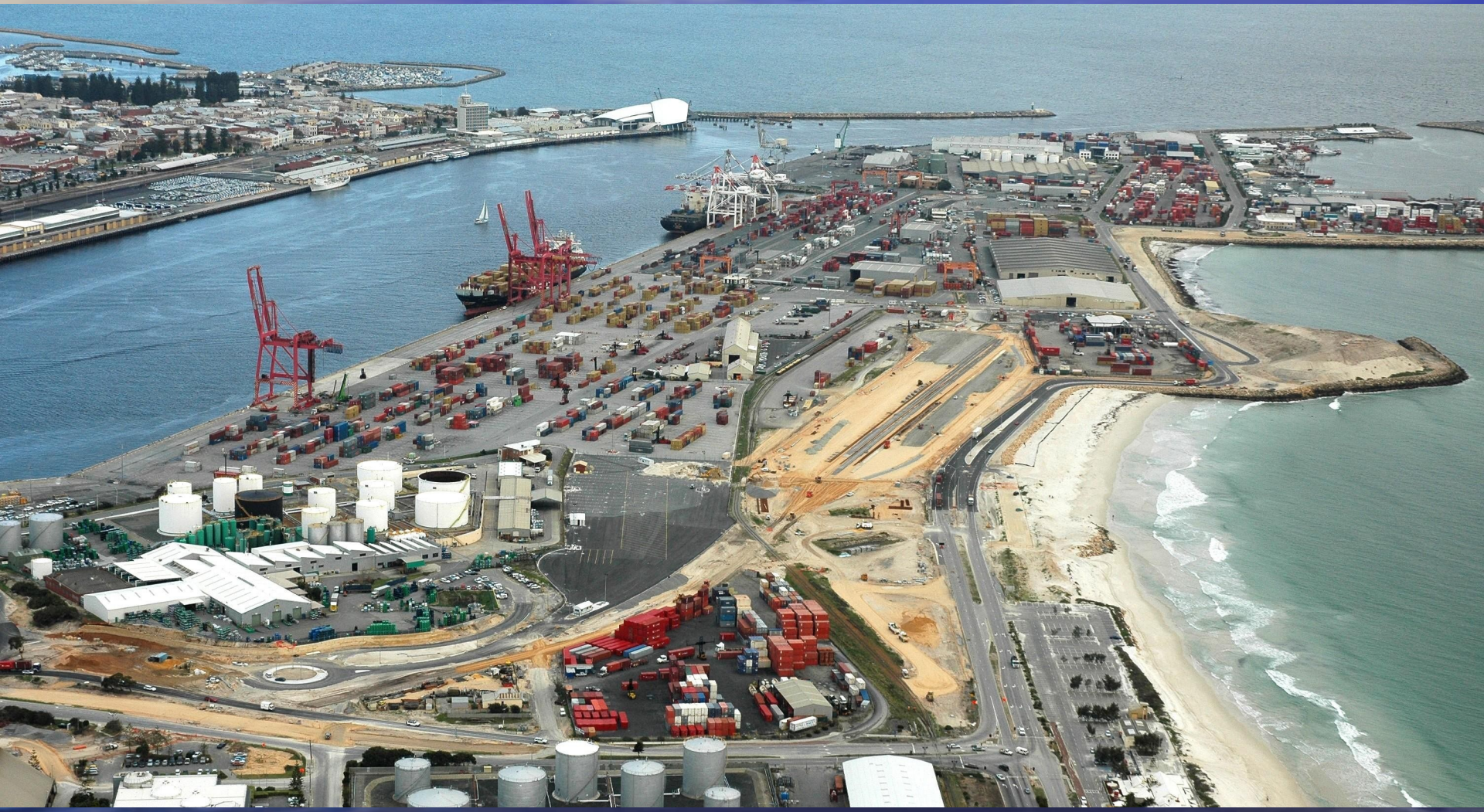
Sample Simulation

~4 minutes, 30 seconds

Conclusions – Subsurface 3D Modeling

- The application is a benefit to the waterborne transportation industry
- Provides a focal point for all interested parties to view a site's physical arrangement – proves a universal understanding among a group
- An interactive viewing section allows a user to navigate through the model
- Maximizes effectiveness of data collected
- The waterfront is an integral part of the world's economic infrustructure -its sites should be evaluated before commencing any undertakings that could alter its character or use

Questions?



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